Center Independent Research & Development: JPL IRAD

Exploring and Sampling Recurring Slope Lineae and Other Extreme Terrains (RSL)

Completed Technology Project (2016 - 2019)

Project Introduction

This project investigates technologies for accessing and sampling extreme terrains on planetary surfaces. A driving application is potential in situ measurements on Recurring Slope Lineae on Mars to inform current hypotheses on the nature and source of this slope discoloration phenomena. This initiative develops and demonstrates mobility to and access of the interior of crater walls reaching 40-50 degrees and in situ measurements below the surface. The research primarily focuses on two technologies: (1) rappelling mobility across hundreds of meters of sloped traverses and (2) above-surface mobility (rotorcraft or rocket) for delivering payloads on sloped terrain.

This research project will define science traceability matrix for both dry- and wet-flow hypotheses for RSL on Mars, define the science concept of operations, and define a representative payload to constrain access options. The project will develop and demonstrate two access technologies. The first will focus on rappelling tethered mobility for in situ investigation on both RSL and nearby regions across a diurnal cycle and will include below-surface access to a depth of 3–15 cm for embedding a dielectric probe. The second will focus on above-surface access using a helicopter or a rocket that will deliver a 4+ kg payload on RSL slopes. Component technologies include extreme-terrain robotic mobility, deployment of payloads on slopes, autonomy, below-surface access and in situ measurements on slopes. This work will culiminate in a field test at a terrestrial analogue site.

Anticipated Benefits

Advancing autonomy in general and autonomous surface mobility in particular could benefit current exploration missions.

RSL lie in terrains that can be classified as extreme. They are often located on the interior of crater walls with average slopes of 25-35 degrees. Technologies that enable access to RSL would expand NASA's planetary surface mobility to more extreme terrain. In 2012 and 2015, the National Research Council ranked extreme-terrain mobility among NASA’s top sixteen technologies to develop in the near term. This work will help the Mars Program gain critical understanding, and thereby inform a potential future mission on how to conduct science operations on terrains that exhibit dynamic changes to their surfaces. Rappelling mobility would also be applicable to accessing lunar cold traps, exploring lunar and martian pits, and venturing into crevasses on Europa and Enceladus.

Extreme terrain access of highly-sloped surfaces could find potential applications in future resource harvesting from permanently-shadowed lunar craters as well as from RSL. This capability could also find potential applications in both open-pit and underground mining. Rappelling mobility could benefit search and rescue missions for underground mines, providing access to trapped miners and potentially saving lives.

Artist's concept shows a mobility platform with a rappelling roving subsystem acquiring in situ measurements on sloped terrains.

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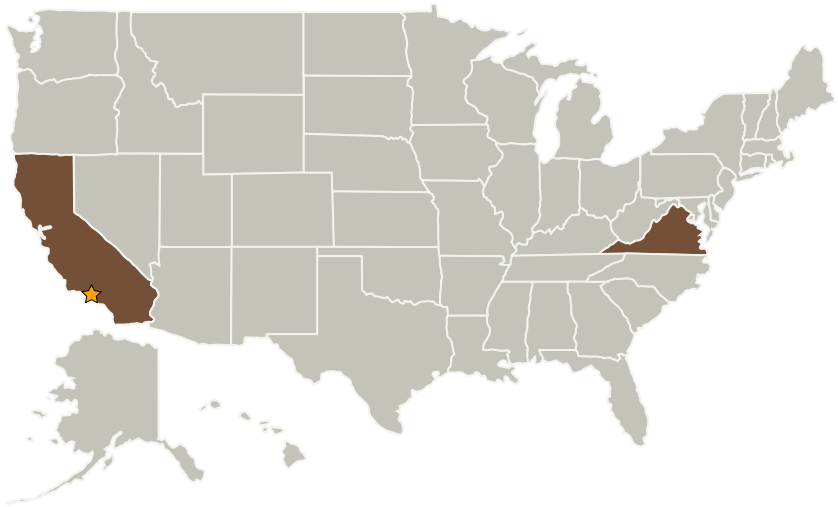
The technology for autonomously delivering payloads on sloped terrains under challenging wind conditions could be of relevance and interest to the Department of Defense. Extreme-terrain mobility could also have relevance to the U.S. military and to search and rescue missions.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Co-Funding Partners	Type	Location
Luna Innovations, Inc.	Industry	Roanoke, Virginia

Primary U.S. Work Locations	
California	Virginia

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Issa A Nesnas

Co-Investigators:

Robert C Anderson
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Joel W Burdick
Laura A Kerber
Gareth N Meirion-griffith

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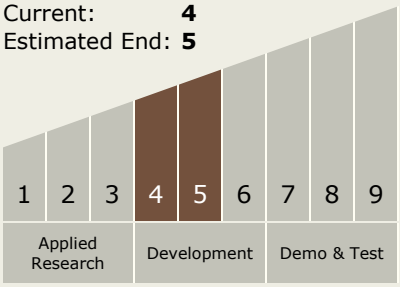
Images

JPL_IRAD_Activities Project Image
Artist's concept shows a mobility platform with a rappelling roving subsystem acquiring in situ measurements on sloped terrains.
(https://techport.nasa.gov/image/28014)

Technology Maturity (TRL)

Start: **4**
Current: **4**
Estimated End: **5**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.4 Surface Mobility

Target Destinations

The Moon, Mars, Others Inside the Solar System

Supported Mission Type

Projected Mission (Pull)